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ABSTRACT

This paper proposes some possible areas of research and tentative theoretical guidelines for the Learning in Science Project (Primary)-- LISP(P). This new project, designed to investigate the teaching and learning of science in the primary school, arises from the work of the original Learning in Science Project (LISP). LISP(P) has two complementary components-- an investigation into the problems and difficulties that primary school children have in learning science and the training of primary school teachers to teach science. These components will be investigated during three phases. An exploratory phase will be conducted to examine primary teachers' perceptions of science and science education and their concerns regarding science teaching, and to observe students in classrooms as they participate in activities which are related to science. Proposed areas to be investigated during the next (in-depth) phase include: concepts and concept formation; student explanations as to why particular instances are or are not examples of a concept; students' thinking and practical skills; students' understanding of technology and society; and student attitudes. The nature of the final (action-research) phase has not been formulated. However, if it follows a pattern similar to LISP, it is suggested that teachers will become involved in both the in-depth and action-research phases. (JN)

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LEARNING IN SCIENCE PROJECT (PRIMARY)

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TOWARD A FRAMEWORK

SE 045 303

Science Education Research Unit
University of Waikato
Hamilton, N.Z.

2 Working Paper No. 101

TOWARD A FRAMEWORK

Roger Osborne

January 1982

A Working Paper of the Learning in Science Project
(Primary)

INTRODUCTION

This paper proposes some possible areas of research and tentative theoretical guidelines for the Learning in Science Project (Primary) - LISP(P). This new project, to investigate the teaching and learning of science in the Primary school, arises out the work of the original Learning in Science Project. LISP investigated the teaching and learning of science at the 11-14 year old level, and I will first review those outcomes of LISP which have implications for the Primary Project.

The first phase of LISP enabled those of us involved in the research to become familiar with Form 1 - 4 Science and to explore those issues which were of concern to pupils, ex-pupils, teachers and others. The Project deliberately focussed on issues not emphasized in traditional evaluation, e.g. teacher and professional body criticism of the stated syllabus, and in the second phase of the Project focussed on the learner. In particular we investigated the meanings for words, and explanations for how and why things behave as they do, which are brought by the learner to the classroom. We also investigated the impact of typical classroom experiences on these ideas. The work of the second phase of the Project was undoubtedly the major effort of the Project. A wealth of material on children's meanings for words and views of the world was obtained and this led to a number of publications in New Zealand, Australia, U.S. and U.K. There has also been a considerable interest in the techniques used to acquire the findings. The techniques were in part developed, and in part refined, during the early stages of the project.

The success of this work, combined with considerable frustration in attempting to do worthwhile research related to the so called "process-skills" objectives of the N.Z. Syllabus, led us to emphasize in our science classroom investigations the knowledge structures in children's minds and the impact of learning experiences on these structures. In part our lack of emphasis on process skills reflects the philosophical disarray of the listed process skills, the artificiality of isolating individual skills, and the minimal interest of most teachers of science in giving prime emphasis to process skills in their teaching.

Our work on children's outlook on science tended to seek out fundamental causes for children's attitudes and feelings towards science. This led us, in some respects, away from the classroom, to parental and societal influences on children. The implications of this work for teaching remains to be fully explored.

The final (action-research) phase of the project revealed the difficulty of sharing with practising teachers our commitment to seeking solutions to the problems we had uncovered, of working through with them the implications of the research, and of involving them in the development of viable solutions to the identified problems. Possibly the effort we placed in seeking the underlying causes of the problems in learning - rather than concentrating on superficial manifestations of the problems which are possibly of more immediate concern to teachers - left us with a difficulty in communicating our ideas and philosophy to some of the teachers involved in the action-research phase. In retrospect I think we underestimated the communication problem. On the other hand I believe the concern of the project with fundamental issues was the right one. Despite the problems some real advances were made. Solutions to some of the problems have been found. In other cases clear leads and ideas for future research and development have been provided. Both in New Zealand and Australia many science teachers are now much more aware of children's ideas and of the importance of taking these into account when teaching.

PRIMARY PROJECT

Let us now turn to the primary project. This project has two complementary components. Firstly an investigation into the problems and difficulties that primary school children have in learning science, and secondly consideration of the training of primary school teachers to teach science.

The first component is similar in many respects to the aims of LISP and naturally follows from that Project. With respect to that component, the success of the three phase LISP plan, and the success of the research methods used, suggest that a similar overall design and methodology should be maintained in LISP(P). Further, much of our Science Education

research work at Waikato is increasingly being guided by our appreciation, based on our research and that of other groups at Monash (Australia), Paris (France), Surrey (U.K.), Pittsburgh and Cornell (U.S.) Universities, that children have prior ideas which have a really significant influence on learning and that children influence their own learning beyond our previous expectations. This view is gaining increasing acceptance in cognitive research and finds support in the theoretical models of Kelly (1969) and Wittrock (1974). The Science Education Research Unit at Waikato provides one of the major empirical inputs to science education work in this area, and our expertise and interests are ones we should build on. It seems to me that unless there are good reasons otherwise LISP(P) should continue the focus on the learner, on the learner's prior experiences, memories and knowledge, and on the influences of teaching on these constructions of the world.

EXPLORATORY PHASE

Undoubtedly the place to start the research, is talking to primary teachers about their perceptions of science/science education[1] and their concerns regarding the teaching of science, and to observe pupils in classrooms as they do activities which are in some ways related to science. Such activities are likely to be right across the curriculum. For example, in view of our findings about 'animal' (Bell, 1981) it appears that certain non-science activities in classrooms may have considerable impact on children's meanings for words and views of the world. This impact could influence children's feelings toward science and their motivation to investigate the world around them, as well as influence their knowledge. For example, lack of emphasis on science and technology and an overemphasis on politics and wars in historical studies and projects, may lead to pupils developing a low image of scientists and their contribution to society. Undue emphasis on animistic and anthropocentric viewpoints in language work e.g. "The car didn't want to go around the corner", or the complete lack of distinction between

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1 Without an idea of what a primary school teacher means by science, the teacher's concerns about teaching science are unlikely to be clarified or interpreted correctly.

fantasy and reality in reading or writing e.g. "The cow jumped over the moon", may have a really negative influence in terms of providing a sound conceptual base for the development of scientific ideas. In other words, primary teachers probably influence learning in the area of science both positively and negatively, as they teach other subjects; teachers are effectively influencing learning in science whether they consider they teach science or not. This hidden curriculum in science is one which the LISP work suggests is important and it is one we need to explore at the primary school level.

IN-DEPTH PHASE

Let us now turn to what aspects of learning science could form the foci of any in-depth phase of LISP(P). The following are tentative ideas and are not proposed to pre-empt research on issues that may follow from the exploratory phase discussed above. The seven categories used to discuss possibilities follow from Fensham's recent categorization of the aims of science (Fensham, 1981).

(i) Concepts - The work of LISP could be extended to the primary school. Recent trends in research in science education suggest to me that there is likely to be a regrowing interest in the importance of certain concepts in primary science. These concepts are not the sophisticated 'basic' concepts of science which have been given recent prominence e.g. concepts related to energy and ecology and particulate models of matter, but rather the more elementary concepts involved in explanations and often confused with everyday concepts. Harlen (1981) includes the concepts of animal, plant, living, materials, movement (speed and force), soil and electric current. Some of these topics, e.g. animal and living, have already been considered at the primary school level by LISP.

(ii) Explanations - Explanations for why particular instances are, or are not considered to be exemplars of a concept, and explanations for how and why things behave as they do, are central both to children's and to scientists' views of the world. While the LISP work has touched on these issues, we are only beginning to think about the nature of children's explanations and about how these explanations are, or can be, influenced by teaching. For example if a child has an explanation for a particular happening, however inadequate it may appear to a teacher, then it may well be that the child has no interest in alternative explanations (Symington, 1981). The problem of engendering an interest in an alternative explanation is of central importance in teaching science. In Appendix A some examples of the types of explanations children have, and in what way such explanations differ from those of scientists are described. This whole area would appear to be a most worthwhile area of study under the LISP(P) umbrella.

(iii) Thinking skills - In the LISP work our attempt to do research on specific process skills was unsuccessful for reasons already mentioned. I would propose that the non-psychomotor process skill we should investigate is the skill of investigating or problem solving. In line with our previous research on knowledge, we would be interested in children's ways of investigating things and in how these are influenced by classroom experiences. More specifically: What is the nature of the happenings which children perceive as worth investigating or containing a problem worth attempting to solve? What natural strategies (i.e. prior to learning science) do children tend to use to solve a problem? Do they plan an investigation? If so, in what way? How do the strategies children tend to use to solve problems differ from scientists' strategies

for solving problems and investigating things? Greeno (1981) suggests that the distinction between knowledge and problem solving is not as clear as it once was, and it seems unlikely that this investigation could be usefully undertaken in isolation from (i) and (ii) above.

(iv) Practical skills - I would include in this category, psychomotor skills e.g. weighing out a specific amount of sand, reading a meter, and investigating habits e.g. care of animals/equipment, concern for accuracy. It may be useful to distinguish between a pupil's practical ability, considered here, and the probability that appropriate use will be made of the ability and the reasoning behind that use, which might better be considered under (iii) above. I am unsure at this stage how much research emphasis should be placed on this category.

(v) Technology - What do children tend to know about the technological world in which they live? For example, how do young children think that a fridge works? How do they think a steam engine works? What impact does teaching have on these ideas? Do children distinguish clearly between the natural and technological worlds and what is the nature of children's distinctions? What impact does teaching in primary schools have on children's ideas about technology? Work done on this topic could be complementary to, and linked with, other Science Education Research Unit work in this area. (Cosgrove).

(vi) Society - What image do primary school children have of science and of its relationship to themselves and to society? How is this influenced by teaching across the curriculum? How are newsworthy aspects of science in the community, the nation, or the world handled in the classroom? What efforts are made to take children

beyond the classroom walls to find out about scientists and about scientific activities in the local area? What impact do such activities have on children's thinking? Recent political moves by non-scientists to influence scientific activities, for example in the U.S., increase the importance of this objective in science education. The importance of the above questions with respect to the N.Z. primary syllabus and with respect to LISP(P) is more debatable.

(viii) Attitudes - As Kelly (1969) implies children's feelings toward science (and technology) cannot be usefully isolated in research from other aspects of science education. All the previous categories influence attitudes to science as do other factors such as parental and peer pressure. While superficial psychometric studies are not difficult in this area of research, really worthwhile and valuable research relatable to classroom practice remains extremely difficult. I would suggest that any research about feelings towards science undertaken as part of LISP(P) should be subsumed as part of research on one of the previous six categories.

In my view, emphasis on (ii) and (iii) above may be the most productive research area for LISP(P), provided this gains support in the exploratory phase of the project. It would provide a new challenging research exercise which builds on the work of LISP and yet which would complement rather than elaborate the LISP work. I think it has exciting possibilities.

ACTION-RESEARCH PHASE

At this stage it is quite unclear what the nature of such a phase would be if it even existed. However if it does follow a similar pattern to LISP, certain lessons can be learnt from the earlier project. For example, if practising teachers are to actively participate in that phase, consideration should be given to more fully involving them in the

earlier in-depth phase of the work. In this way teachers would have the opportunity of becoming more philosophically oriented toward the research problem and more committed to seeking solutions. Such an involvement of teachers earlier in the research may ensure that the in-depth phase of the Project maintains its potential relevance to teachers, and may ensure that the time spent in orienting teachers at the beginning of the action-research phase (a whole term with LISP) is greatly reduced.

THE TEACHER TRAINING ASPECTS OF THE RESEARCH

With regard to this component of LISP(P), this work is already in progress, building on the ideas and findings of LISP. Possible implications for teacher training of the LISP work and other similar work overseas, have been mentioned briefly in other papers.

A relevant extract from Osborne, Bell and Gilbert (1982) can be found in Appendix B.

CONCLUSION

This is a kite flying paper designed to raise issues and set out some possibilities related to the Learning in Science Project (Primary). If the paper provokes discussion and helps in planning the research it will have served its purpose.

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APPENDIX A

TYPES OF EXPLANATIONS IN CHILDREN'S SCIENCE?

Looking for likeness	____	It is like an ant, and an ant is an animal.
	____	It is like putting salt in water and that's dissolving.
Linking to self-experience	____	It can't just stop because there is a force inside it, just like when you are running and you can't stop suddenly.
Cause-effect inseparable	____	The smoke is the ending of a flame. When something burns substances disappear.
Cause and effect reversed	____	Moving trees cause the wind.
Non-observables don't exist	____	There is no electric current because you can't feel anything.
Observables have reality	____	The coldness in the jar is trying to get out.
	____	The gravity comes up the pole, along the wire and holds the bird on the wire.

SCIENTIST'S EXPLANATIONS	versus	CHILDREN'S EXPLANATIONS
Coherence between explanations of different situations.		Incoherence between explanations of different situations.
Separation, and order, of cause and effect very important.		Cause and effect often not perceived as separable or order is not considered important.
Not limited by personal first hand experience nor by lack of direct observations.		Tend to link explanations to personal experience or direct observations only.
Clear distinction between reality and explanations and models of that reality.		No clear distinction between reality and explanations and models of that reality.

APPENDIX B IMPLICATIONS FOR TEACHER TRAINING

Extract from Osborne, Bell & Gilbert (1982)

IMPLICATIONS FOR TEACHER TRAINING

In this paper we have attempted to clarify ideas about children's science and to consider the implications of this knowledge for science teaching. One aspect of science teaching and learning which we have not considered is the view held by teachers. As Vincentini-Mossori (1980) points out, this is a particular problem with primary school teachers who normally have studied tertiary level subjects in the fields of education, humanities and social science, with some elementary mathematics and very little or nothing of natural sciences. In their professional activities as teachers they are continually confronted with samples of children's (or layman's) science presented to them by pupils and parents. Scientific ideas, therefore, if they are acquired at all during school years, remain notions incompletely related to everyday experiences and are, therefore soon forgotten.

From our observations what is taught in the name of science is frequently a mixture of the teacher's own views (which may be largely children's science) and textbook quotations of scientists' science, or curricular science.

This has implications for the training of primary school teachers, and Vincentini-Mossori (1980) discusses attempts she is making to overcome this problem. Personally, we are optimistic that if teachers' college students are introduced to children's science first, they then might be easily encouraged to clarify the differences between these views, their own views and those of scientists. Many primary teacher trainees have a rather negative attitude to science based on their secondary school experiences. The suggested approach above attempts to build on students' interest in children and attempts to dissociate science at teachers' college from negative secondary science experiences.

At the secondary school level the situation is not so serious. Admittedly, secondary school teachers are often trained only in one scientific discipline. However this training at least introduces them to aspects of scientists' science: the rationale and purpose of science have often been understood. Such teachers usually appreciate that they have deficiencies in certain areas of their knowledge, and they have access to school colleagues who can help them with specific deficiencies. On the other hand, secondary school science teachers are largely unaware of children's science and are frequently not sensitive to the viewpoints children bring with them to science lessons.

It is therefore our view that both primary and secondary teachers need to be made aware of both children's science, and of scientists' science, and to clarify where their own views lie with respect to these two views. With respect to children's science, teachers in training can be made familiar with what is known about children's science to date (see Appendix). Further they could use many of the techniques described by Fensham et al (1981) to undertake small scale investigations of children's science in schools and the views of their teachers' college peers.

In our experience this provides excellent opportunities for students to clarify their own ideas and to provide them with a sound orientation on which to base good science teaching. The following is an extract from the conclusion of a teachers' college student's report on her investigation of children's meanings for the word 'solution' using an approach suggested by Osborne and Gilbert (1980). While the comments might have been more qualified, the student's enthusiasm and orientation is clearly apparent!

> "The results of my investigations cannot be ignored by teachers. The children in this study do not appear to be aware of the appropriate use of both the common and scientific meanings of the word <u>solution</u>. Because children do seem to have their own concepts of the word (not necessarily a scientific one) it is the job of the teacher to clarify (various) meanings of the word and help children distinguish between them. Above all the teacher should not <u>assume</u> that children have a single scientific concept of words like solution but be aware that they may have their own meanings. Discrepancies in the meanings children and teachers have for words may occur in other areas of science. Wherever possible teachers should make an effort to investigate children's meanings for words and views of the world around them".

We have advocated that teachers should have a greater knowledge of, and respect for, children's science. What children think can be developed by causing them to reflect on, and discuss, its consequences. It follows naturally that teacher education can, and should, proceed in an analogous manner.

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